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Traffic Flow Modeling for Heterogeneous Conditions on Urban Road - A Case Study of Selected Stretches of Ahmadabad city

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***Abstract*— Knowledge of fundamental traffic flow characteristics and vehicle behavior are essential for operation of transportation system. The fundamental characteristics of speed and flow have been studied. An appropriate methodology was adopted to collect data. The methodology for choice of best fitting curve to the observed data has also been described. The result of the study has shown that, the Speed- Flow-density of urban heterogeneous traffic can be modelled for vehicles over a wide range of traffic flow. Speed-flow-Density curves for selected roads were plotted.**

Keywords*— *Flow Modelling, Speed-Flow-Density Relationship

INTRODUCTION

In developing country like India, road traffic in general & urban roads traffic in particular, is highly heterogeneous include vehicles of widely varying characteristics the vehicles share the same road space without separation. Basic knowledge of traffic flow characteristics like traffic volume under such heterogeneous conditions is fundamental traffic volume is basic variable in planning, designing, and operation of roadway systems. The roads of India are a perfect example of the dominant economic difference and vehicle like motorcycle, auto rickshaw, bus, minibus, truck, moped, car, bicycle, tractor, non motorized can be seen sharing the same road space. The traffic condition of Ahmadabad city is highly heterogeneous in nature and vehicles do not follow lane discipline and not follow signal or sign, which makes it difficult to study and analyze traffic flow characteristics. To understand traffic flow relationships have been established between the main characteristics: speed, flow, density.

BASIC FORM OF SPEED-FLOW-DENSITY RELATIONSHIP

Knowledge of relationship between speed, volume and density is very important in traffic studies. Fundamental speed-Flow-Density graphs as shown in fig.1

A. Speed-density relationship

With increase in density the speed decreases. When there is no vehicle (density=0), the speed is maximum. This speed is called “Free speed”. At very high density, the vehicles approach zero speed. This density is called “Jam density”.

B. Speed-Flow relationship

At very low speeds the volume would also be low. With increasing speed, traffic volume also increases up to a certain limit, as headway initially decreases. But as the speed further increases the spacing between the vehicles increases and becomes so large that volume decreases. There is an optimum speed at which the flow is maximum.

C. Flow-density relationships

As the density increases from zero, volume increases up to the point of critical density . the density corresponding to maximum flow. It is called “Optimum density”. There after volume decreases as density continues to increases to a maximum value known as “Jam density” when all vehicles are stopped. As density increases the speed of vehicle is reduced, reducing the flow, till it reaches jam density when there is no movement or flow.

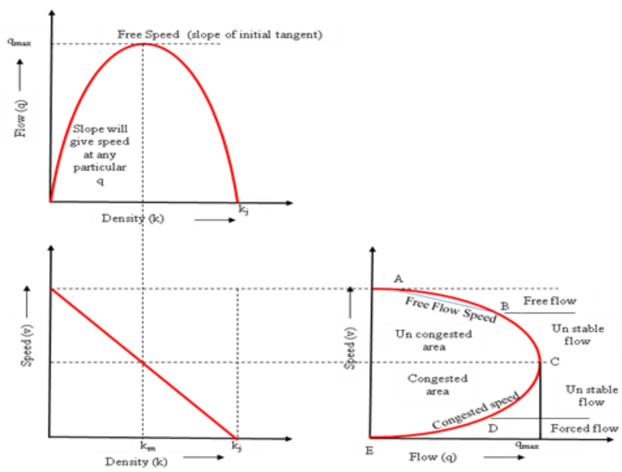

Fig.1: Fundamental diagram speed-flow-density

METHODOLOGY & DATA COLLECTION

The study has been conducted by the Department of Civil Engineering, Tatva Institute of Technological Studies, Modasa. For assessing the existing traffic condition in Ahmadabad City. To study the effect of moving vehicle on the traffic flow characteristics the traffic volume count survey are carried out with the help of video graphy on selected stretches of different stretch lengths during time period.

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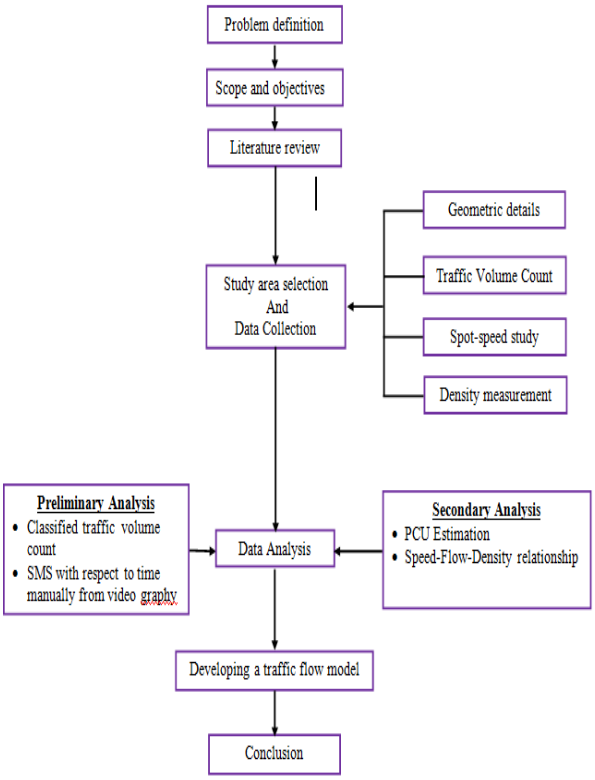

Fig.2: Methodology chart for study

A. Road Geometry

TABLE 1
GEOMETRY OF DIFFERENT STRETCHES

Sr. No.	Road Name	Number of lane(m)	Width (m)	Length (M)
1	Railway station Kalupur To Sakar Bazar	Three lane undivided one way	12.00	260
2	Sakar Bazar To Railway Station Kalupur	Three lane undivided One way	12.00	240
3	Kalupur police Station To Gangaram Tower	Two lane undivided Two way	12.00	400
4	Gangaram Tower To Kalupur police Station	Two lane undivided Two way	11.70	420

B. Traffic Volume count Survey

The most important data are generated through the modern survey techniques like traffic volume count at Different stretches. The extent of variation of traffic flow was as curtained by carrying out twelve hour (8:15:00 AM to 20:15:00 PM) working day counts on Study roads. The traffic volume is expressed as passenger car unit per hour (PCU/hour).Traffic Volume of different stretches are shown in Table no.2

TABLE 2: TOTAL TRAFFIC VOLUME AT DIFFERENT STRETCHES

Road Name	2W	3W	CAR	BUS/ TRUCK	L. C. V.	N.M.
Sakar Bazar To Railway Station Kalupur	22723	17729	4092	1363	709	1601
Railway station Kalupur To Sakar Bazar	21493	14192	4328	1280	564	1461
Kalupur Station To Gangaram Tower	20080	8212	517	2	18	1000
Gangaram Tower To Kalupur Station	18961	7854	540	6	14	983

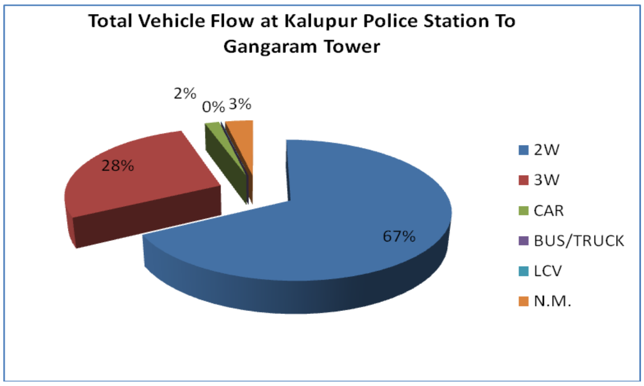

Fig.3: Vehicle Category wise Traffic flow at Kalupur police station To Gangaram Tower

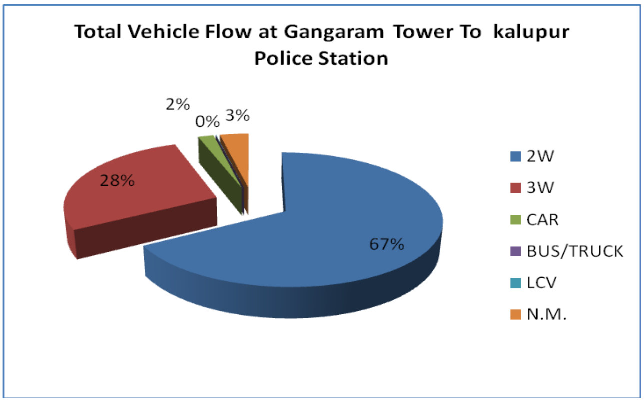

Fig.4: Vehicle Category wise Traffic flow at Gangaram Tower To Kalupur police station

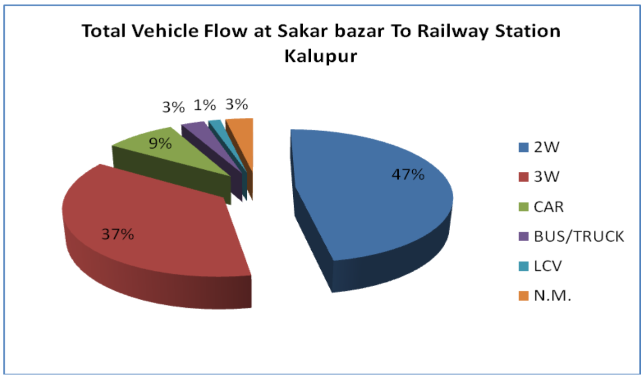

Fig. 5: Vehicle Category wise Traffic flow at Sakar Bazar To Railway Station Kalupur

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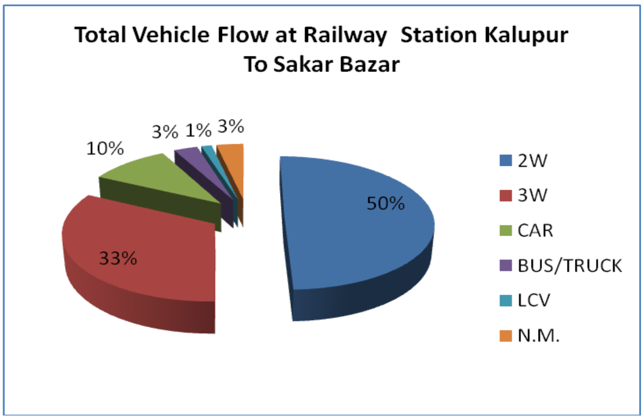

Fig.6: Vehicle Category wise Traffic flow at Railway Station Kalupur To Sakar Bazar

C. ANALYSIS OF COLLECTING DATA

Data collecting from volume count survey are Analysis and measure Space mean speed on selected stretches through every 20 second Flow count continuously and Density is measured through the equation (1). After completed Analysis developed Relationship of Speed-Flow, Speed-Density and Flow-Density. And choice of best fitting curve to the observed data, and develop Speed-Flow, Speed-Density, and Flow-Density model.

$$Q = K \times V \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

Q = Traffic flow PCU/hour

K = Density km/hour

V = Speed PCU/km

Classified Volume count and Space mean Speed is directly measured by video graphy and density measured from equation (1). Different stretches flow-speed-density relationship and its best fitting curves graphs are as under:

1. Kalupur Railway Station To Sakar Bazaar (Moti Bakery)

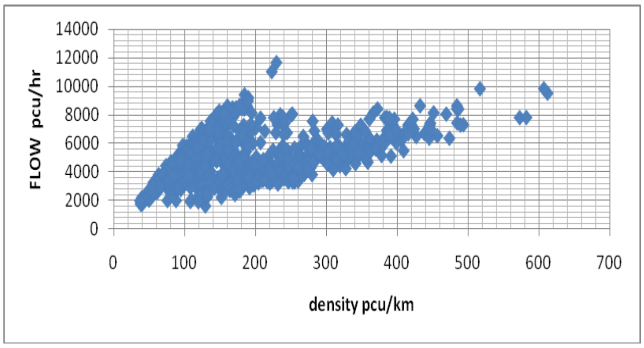

Fig 7: Flow-Density relationship at Kalupur railway station to Sakar Bazar

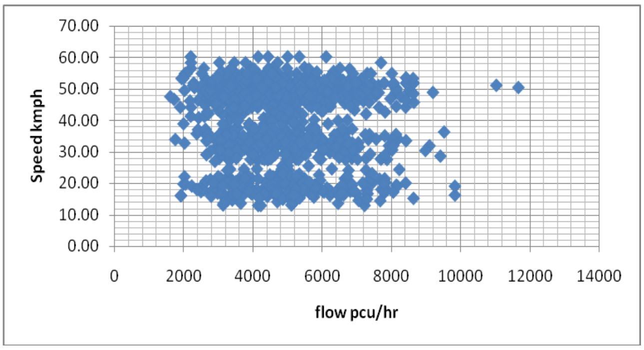

Fig 8: Speed-Flow relationship at Kalupur railway station to Sakar Bazar

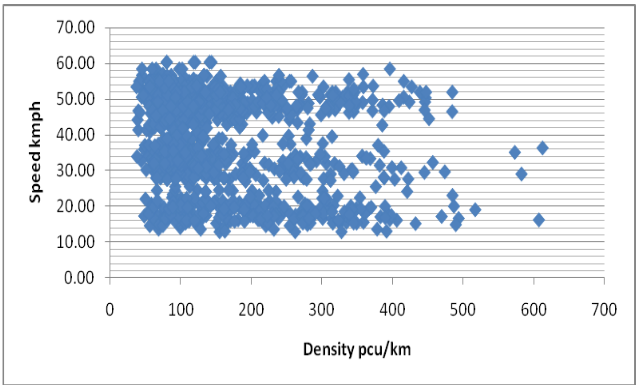

Fig 9: Speed-Density relationship at Kalupur railway station to Sakar Bazar

2.Sakar Bazaar To Kalupur Railway Station

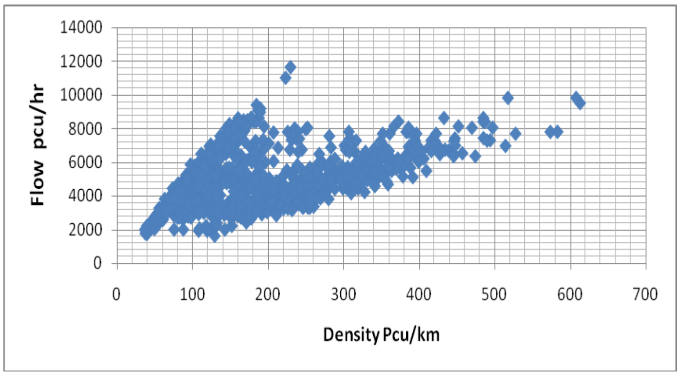

Fig 10: Flow-Density relationship at Sakar Bazaar To Kalupur Railway Station

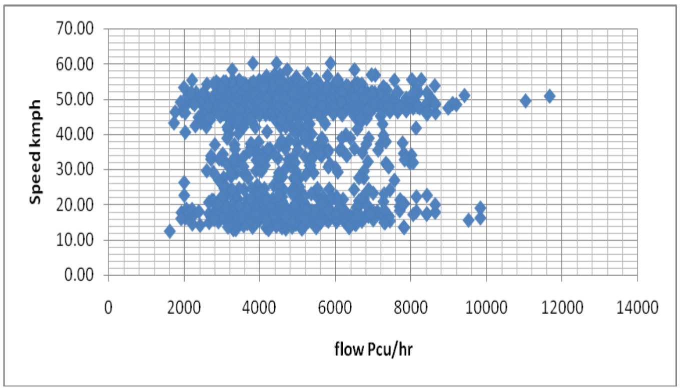

Fig .11: Speed-Flow relationship at Sakar Bazaar To Kalupur Railway Station

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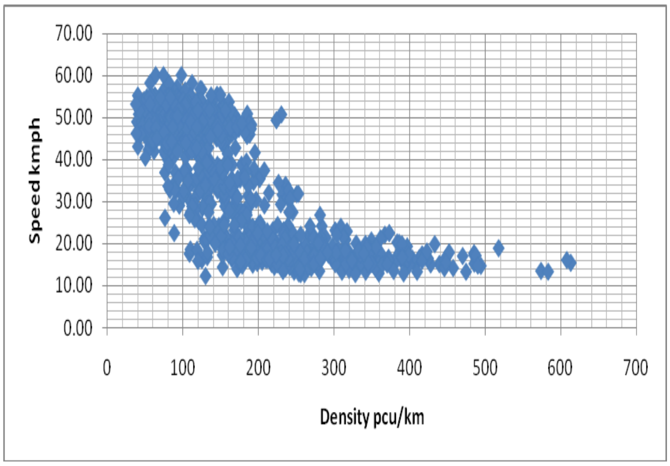

Fig.12: Speed-Density relationship at Sakar Bazaar To Kalupur Railway Station

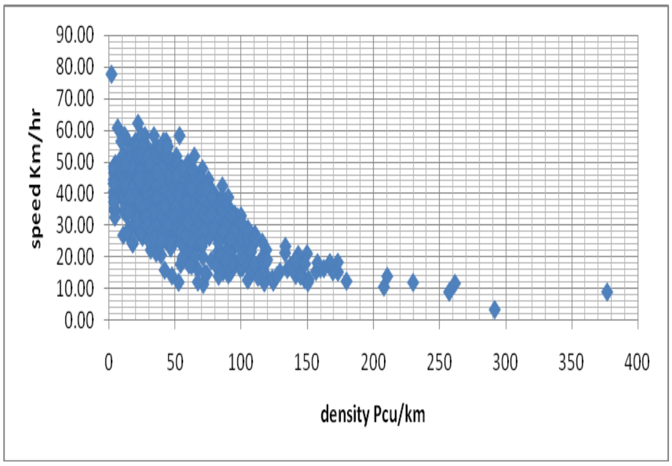

Fig 15: Speed-Density relationship at Kalupur Police Station To Gangaram Tower

3.Kalupur Police Station To Gangaram Tower

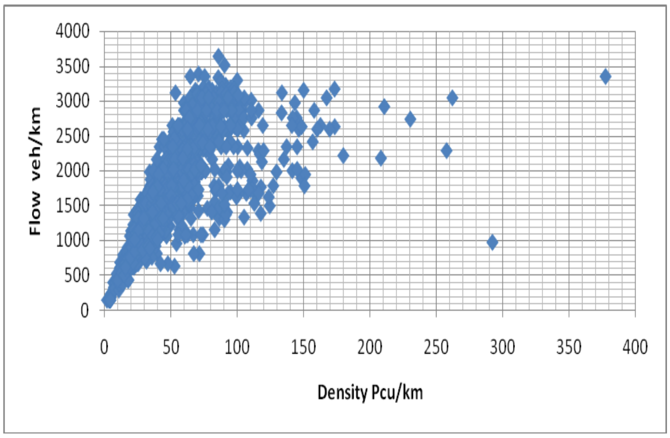

Fig.13: flow-Density relationship at Kalupur Police Station To Gangaram Tower

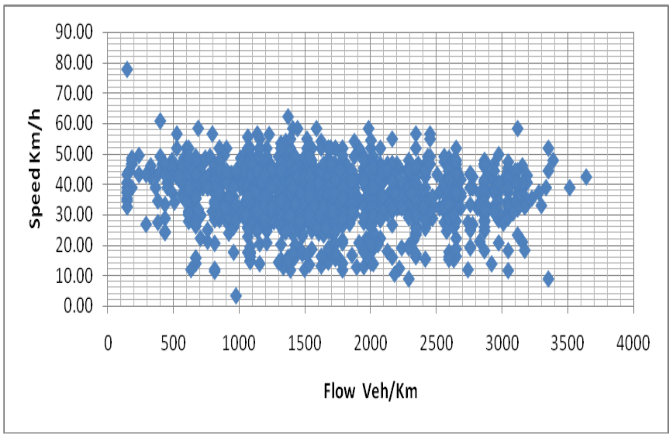

Fig 14: flow-Speed relationship at Kalupur Police Station To Gangaram Tower

4. Gangaram tower to kalupur police station

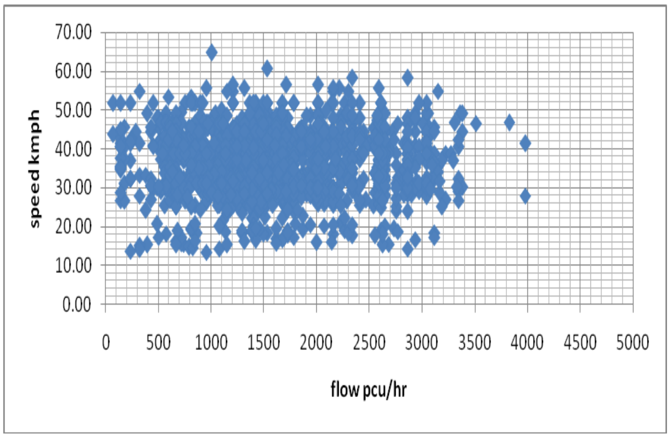

Fig. 16: Speed-Flow relationship at Gangaram tower to kalupur police station

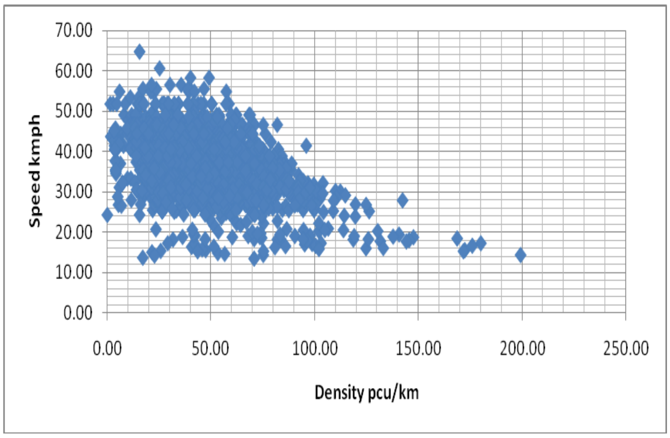

Fig. 17: Speed-Density relationship at Gangaram tower to kalupur police station

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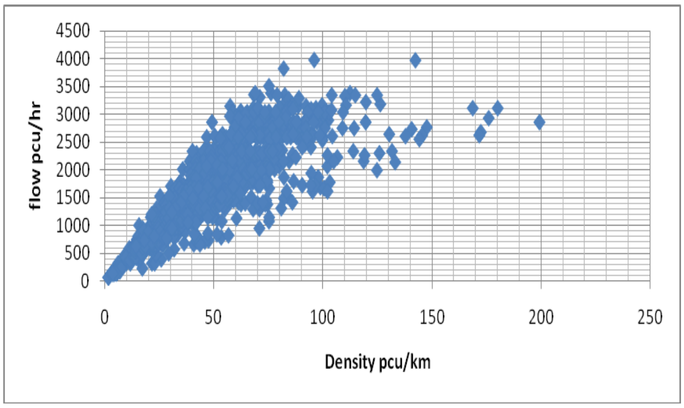
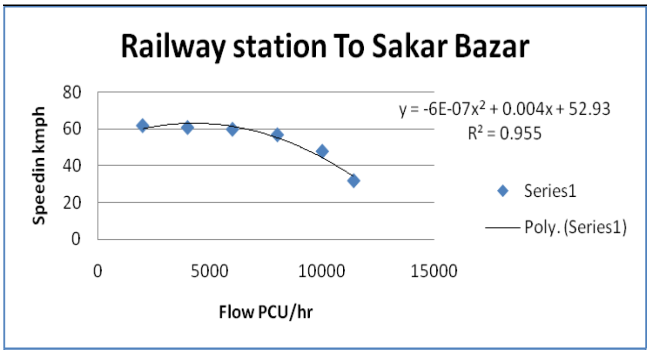
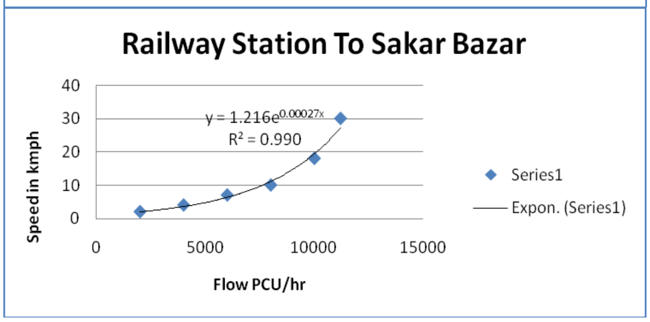


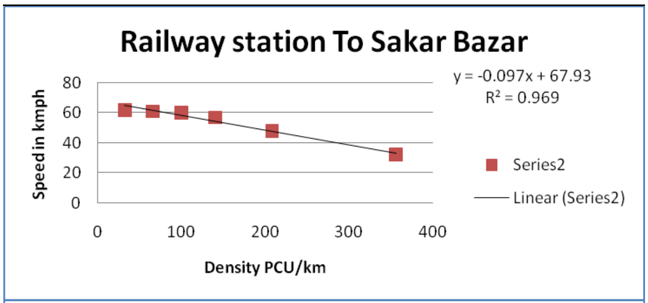
Fig. 18: Flow-Density relationship at Gangaram tower to kalupur police station

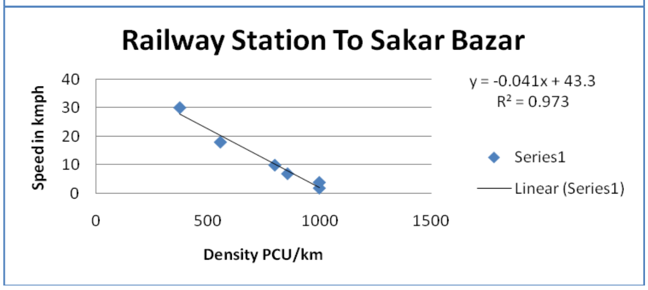
Best fitting curve from above Relationships

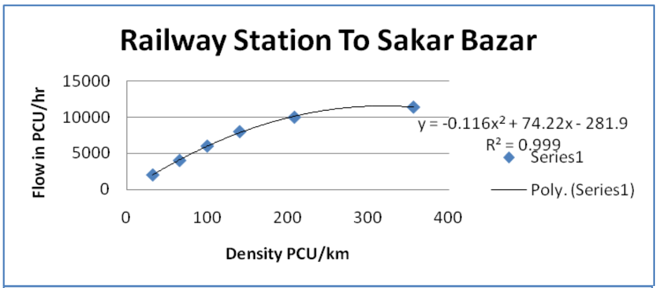
1. *Kalupur Railway Station To Sakar Bazaar*

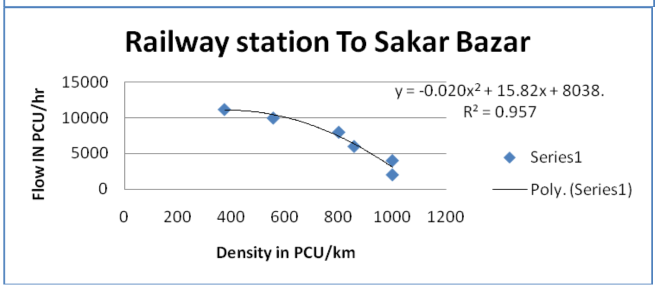




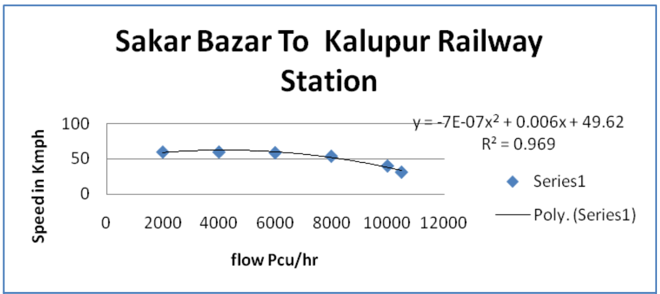


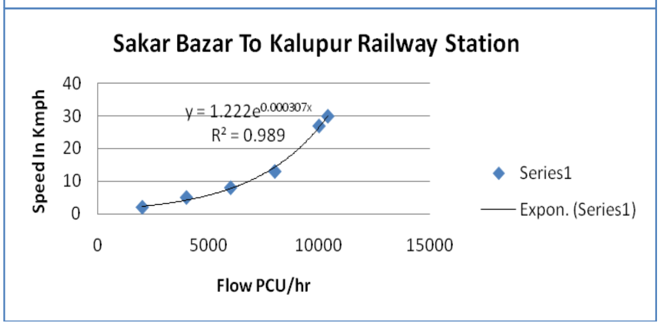






2. *Sakar Bazar To Kalupur Railway Station*





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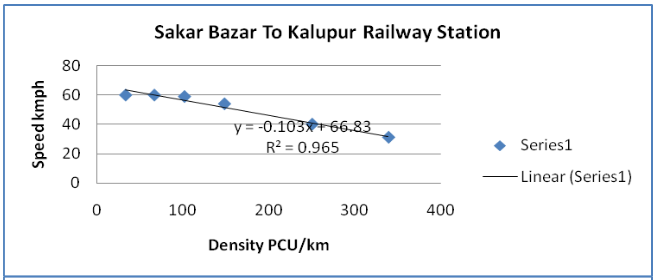
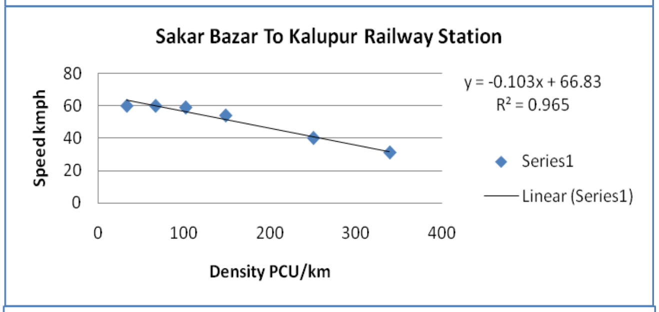
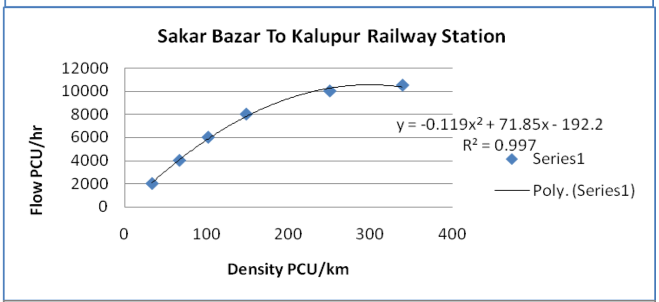
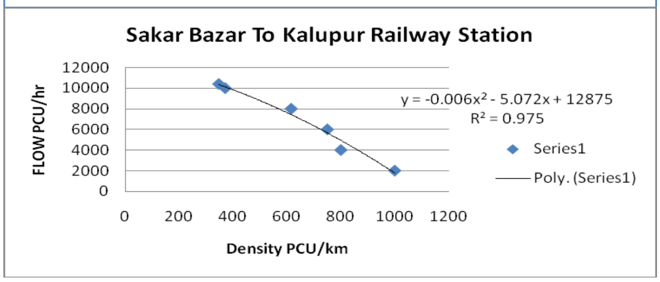
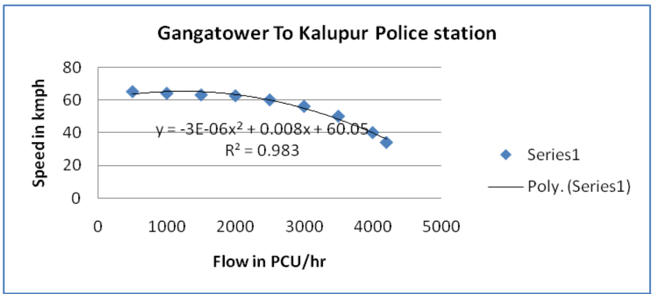


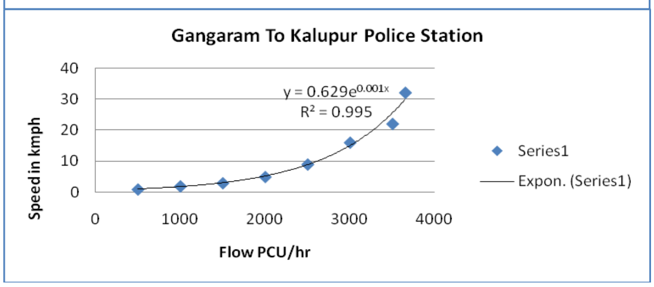


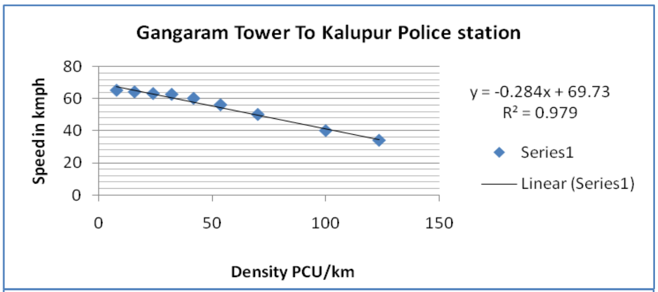


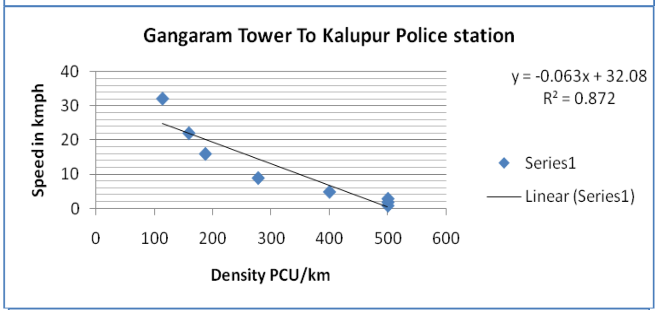


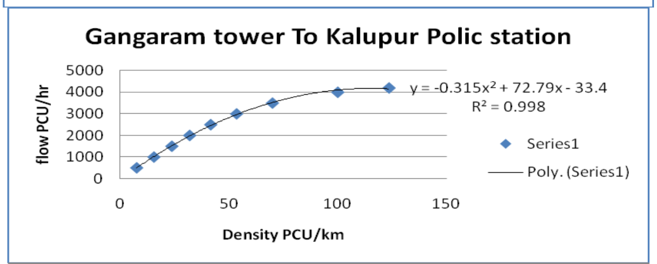
3. Gangatower To Kalupur Police station

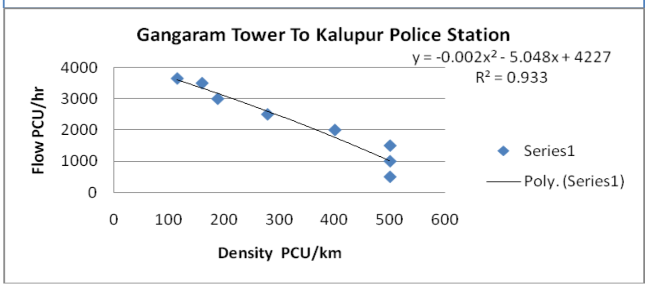




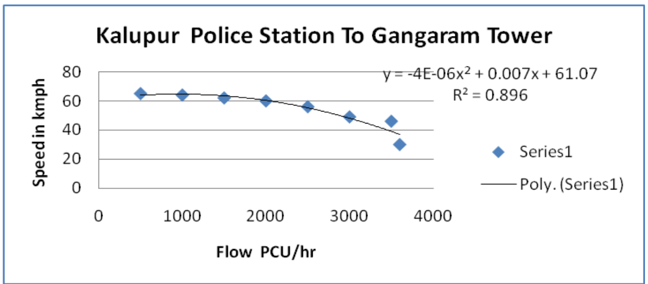


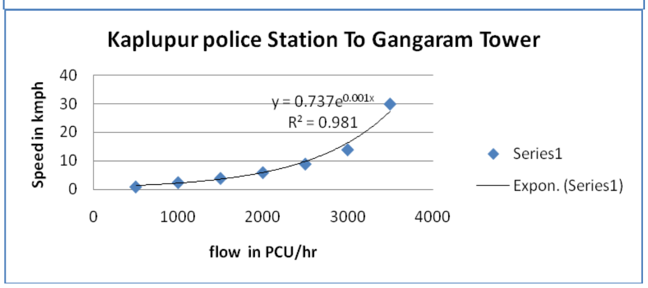






4. Kalupur Police Station To Gangaram Tower





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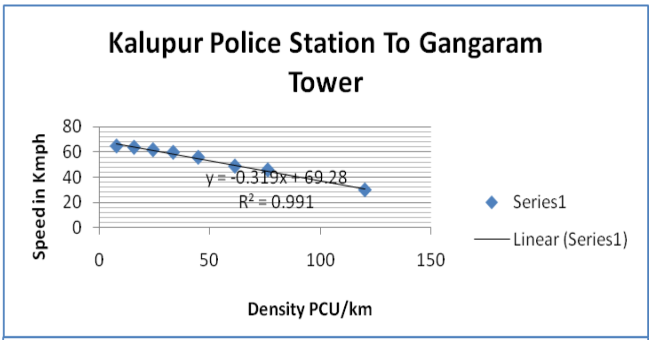

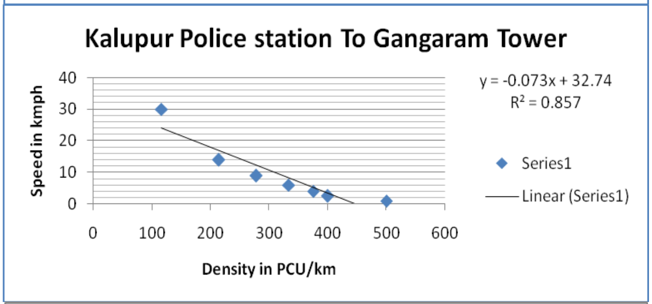

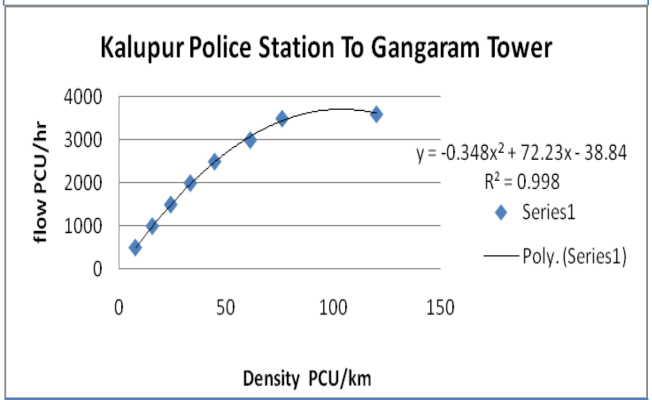

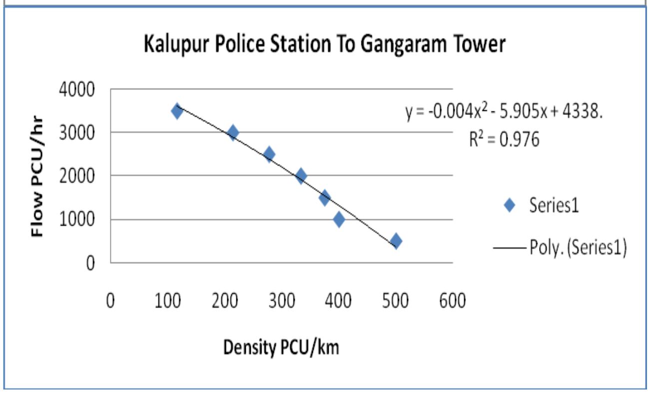

FLOW-SPEED-DENSITY MODELING

Sr. No.	Road Name	Speed(y) - Flow(x) Model	Co-efficient of Determination R^2
1	Railway station Kalupur To Sakar Bazar	$y = -8E\text{-}07x^2 + 0.006x + 48.23$	0.943
		y = 1.817e0.00027x	0.995
2	Sakar Bazar To Railway Station Kalupur	$y = -7E\text{-}07x^2 + 0.006x + 49.62$	0.969
		y = 1.222e0.000307x	0.989
3	Kalupur police Station To Gangaram Tower	$y = -4E\text{-}06x^2 + 0.007x + 61.07$	0.896
		y = 0.737e0.001x	0.981
4	Gangaram Tower To Kalupur police Station	$y = -3E\text{-}06x^2 + 0.008x + 60.05$	0.983
		y = 0.629e0.001x	0.995

Sr. No.	Road Name	Speed(y) - Density(x) Model	Co-efficient of Determination R^2
1	Railway station Kalupur To Sakar Bazar	y = -0.100x + 66.42	0.958
		y = -0.075x + 54.73	0.986
2	Sakar Bazar To Railway Station Kalupur	y = -0.103x + 66.83	0.965
		y = -0.044x + 43.11	0.951
3	Kalupur police Station To Gangaram Tower	y = -0.319x + 69.28	0.991
		y = -0.073x + 32.74	0.857
4	Gangaram Tower To Kalupur police Station	y = -0.284x + 69.73	0.979
		y = -0.063x + 32.08	0.872

Sr. No.	Road Name	Flow(y) - Density(x) Model	Co-efficient of Determination R^2
1	Railway station Kalupur To Sakar Bazar	$y = -0.131x^2 + 76.92x - 502.0$	0.999
		$y = -0.062x^2 + 42.13x + 2871.$	0.943
2	Sakar Bazar To Railway Station Kalupur	$y = -0.119x^2 + 71.85x - 192.2$	0.997
		$y = -0.006x^2 - 5.072x + 12875$	0.975
3	Kalupur police Station To Gangaram Tower	$y = -0.348x^2 + 72.23x - 38.84$	0.998
		$y = -0.004x^2 - 5.905x + 4338.$	0.976
4	Gangaram Tower To Kalupur police Station	$y = -0.315x^2 + 72.79x - 33.4$	0.998
		$y = -0.002x^2 - 5.048x + 4227$	0.933

CONCLUSION

From the survey we find out that our Indian traffic is heterogeneous traffic. It is concluded that existing equation of traffic stream are suitable for these Heterogeneous traffic. According to our complete analysis we found the traffic stream parameters. We get standard relationship between traffic stream parameters. We get a equation for heterogeneous traffic of Ahmadabad city.

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